INTERIOR LAYERED DEPOSITS IN VALLES MARINERIS, MARS: INSIGHTS FROM 3D-DATA OBTAINED BY THE HIGH RESOLUTION STEREO CAMERA (HRSC). E. Hauber[1], K. Gwinner[1], R. Stesky[2], F. Fueten[3], G. Michael[1], D. Reiss[1], T. Zegers[4], H. Hoffmann[1], R. Jaumann[1], S. van Gasselt[5], G. Neukum[5] and the HRSC Co-Investigator Team. [1]Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany; [2]Pangaea Scientific, Brockville, Ontario, Canada; [3]Department of Earth Sciences, Brock University, St. Catharines, Ontario, Canada; [4]ESA, Noordwijk, The Netherlands; [5]Remote Sensing of the Earth and Planets, Freie Universitaet, Berlin, Germany

Introduction: The Interior Layered Deposits (ILD) [1] in the Valles Marineris depressions on Mars [2,3] may be of volcanic [4,5] or sedimentary [6,7] origin. Either way, their presence has profound implications for the formation of the Valles Marineris itself: A volcanic origin might support a formation of the Valles Marineris as a tectonic (rift-like) feature, while a sedimentary origin might support a formation by collapse processes. The High Resolution Stereo Camera (HRSC) on board the Mars Express mission obtains high-resolution stereo and multispectral images, which are particularly well suited for the geomorphologic analysis of the ILD.

Methodology: One key to decide whether the layers are volcanic or sedimentary is their layering geometry, i.e., their strike and dip. Sedimentary, water-lain deposits should have a horizontal layering following an equipotential line, if no post-depositional processes have tilted the layered sequence. On the other hand, volcanic layers from pyroclastic (including subglacial) eruptions, might be inclined, e.g., in tuff cones or as lava deltas in subglacial volcanoes. Their strike and dip should then display a concentric pattern around the vent. Digital Elevation Models and orthoimages derived from HRSC data have been used to measure the strike and dip of several ILD in the troughs of Hebes, Ophir, Candor, Melas, and Juventae Chasmata. Multilinear regression is used to fit planes to three-dimensional coordinates of points selected along layer traces, giving the plane attitude and various fitting statistics. We use the Orion™ software package (http://www.pangaeasci.com/_orion.htm), which has been applied to measure the geometry of layers of the Valles Marineris main canyon walls [8].

Results: To test our method, we measured the layers of a bright-coloured hill which was investigated before with Viking and MOLA data [9]. Our results show good agreement with those obtained by [9] and are given in a companion abstract [10]. Here, we describe the characteristics of two ILD in more detail.

Hebes Chasma. The layering of the ILD within the enclosed depression of Hebes Chasma (Fig. 1) shows dipping values of 10°-20° (layer thickness 3-4 m). The layering is consistently outward dipping and displays a tendency of stratigraphically lower layers to be more steeply inclined than higher layers. A reentrant on the northern part of the deposit is interpreted as the result of a landslide. On the landslide scar, a dark and "bluish" (in false colors) layer seems to have been exposed. The layer is the source of material that flowed down the lower slopes of the wall. We interpret this layer to be mafic, relatively unweathered volcanic ash (similar to the material described by [11,12]). Due to this observation and the layering geometry, a volcanic origin of this ILD seems plausible.

Juventae Chasma. The layering of one ILD at 4.5°S, 297.3°E is mostly subhorizontal (Fig. 2). This particular ILD is also distinguished from the other ILD covered in this study by its morphology (very "homogeneous" and regular layering), as revealed by HRSC, Themis, and MOC images. No clearly developed outward dipping of the layers is observed.

Conclusion: The Interior Layered Deposits (ILD) show various patterns of layer geometry. In addition, HRSC images indicate large differences in their morphology. For some ILD, a volcanic origin seems the most plausible formation mechanism (e.g., Hebes Chasma). In other places (e.g., Juventae Chasma), the case for a volcanic origin is less clear and the layering would seem to be consistent with a sedimentary origin. Clearly, no single scenario can explain the formation of all ILD within Valles Marineris.

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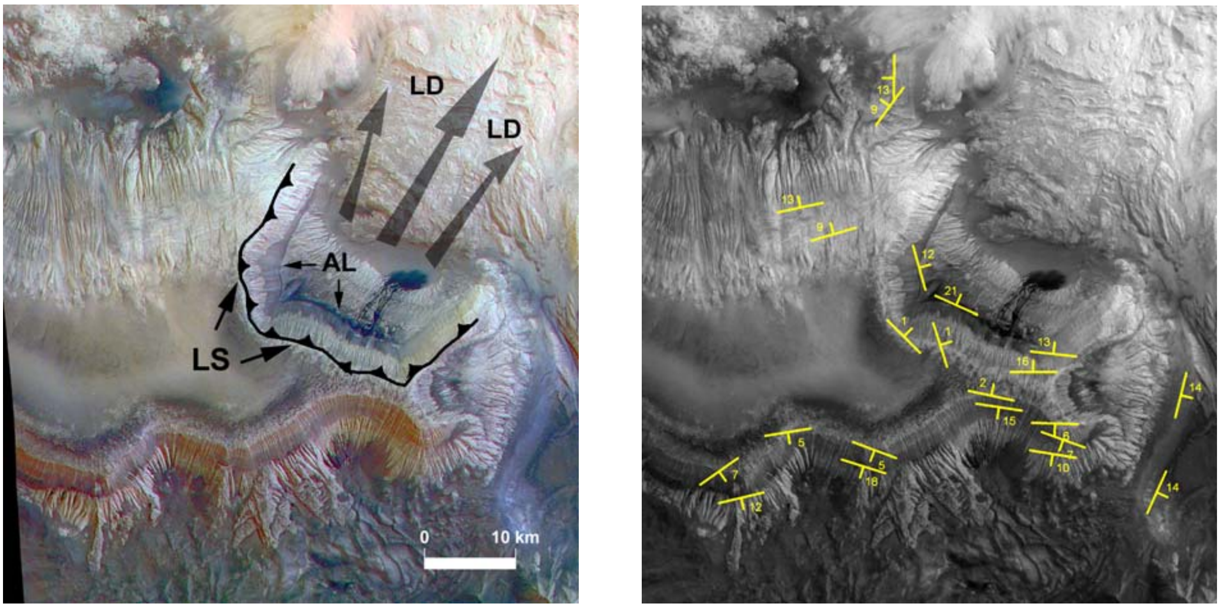

Figure 1: *(left)* HRSC false color image of the Interior Layered Deposit inside Hebes Chasma. The prominent re-entrant at the northeastern side is probably the result of a huge landslide ("LS" = landslide scar, shaded arrows = direction of landslide movement, "LD" = landslide deposit). Note the thin "bluish" layer ("AL"), which might be an exposed mafic ash layer (similar to those described by [12]). Image was taken on orbit 360. *(right)* HRSC image and strike and dip measurements of layers. Note the overall geometry of outward dipping layers, and the tendency of lower layers to be more steeply inclined than upper layers. North is up in both images.

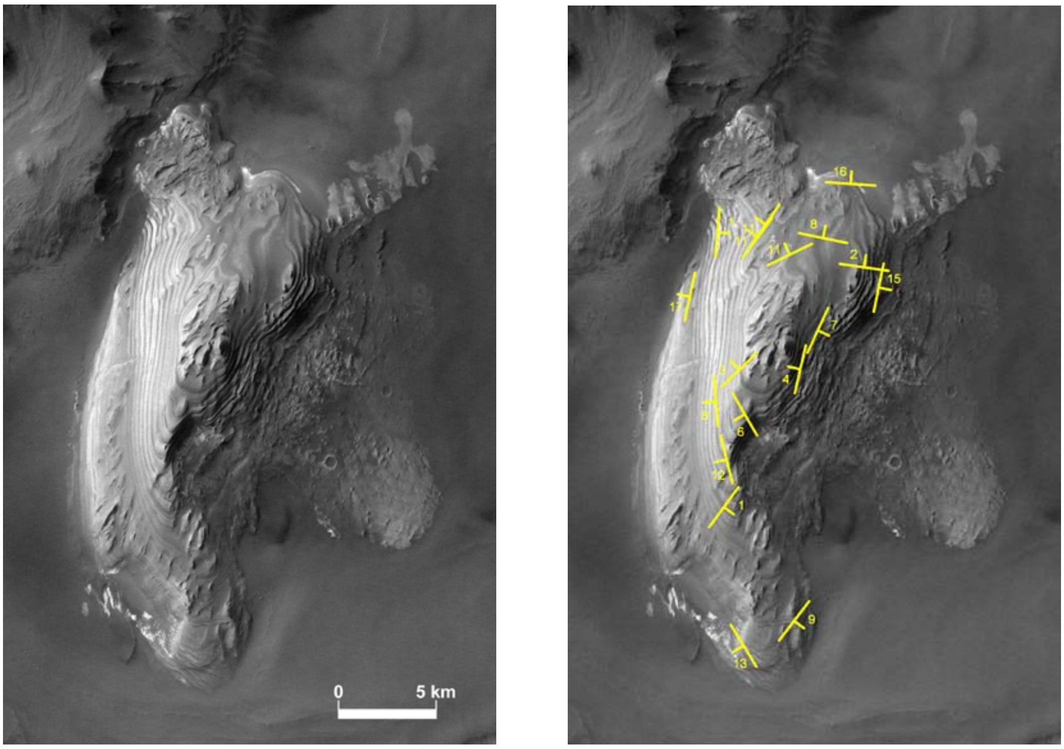

Figure 2: *(left)* HRSC image of ILD in Juventae Chasma (orbit 1070). Spectra [13] indicate the presence of sulfates (kieserite and gypsum) within this deposit; *(right)* Strike and dip measurements. Note the occurrence of very shallow dip values and the absence of a clear tendency for generally outward dipping layers (north is up).